



***SMART AND SCALABLE SATELLITE HIGH SPEED PROCESSING CHAIN***

# Ship detection in Satellite images

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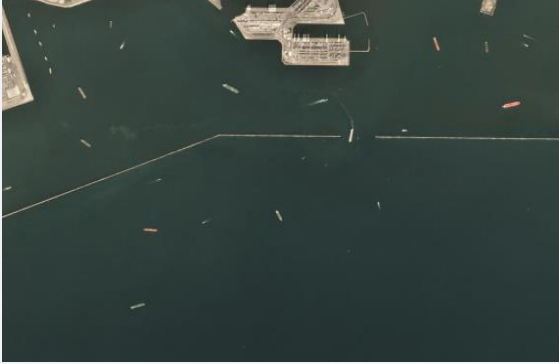
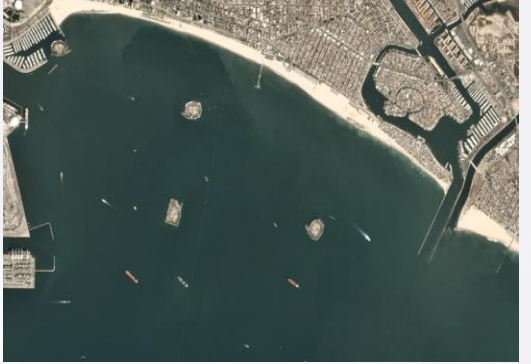


# PATTERN RECOGNITION ALGORITHMS FOR SHIP DETECTION

We have explored classical and AI based approach for ship detection algorithms:

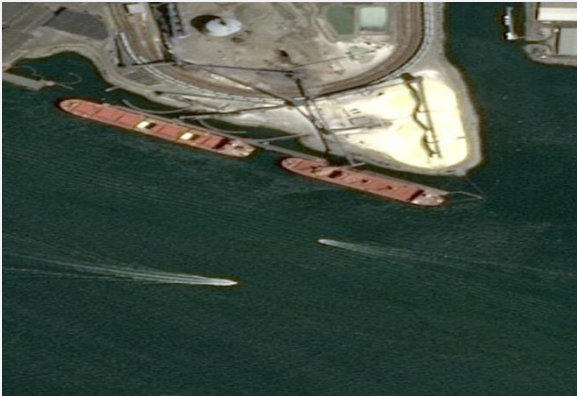
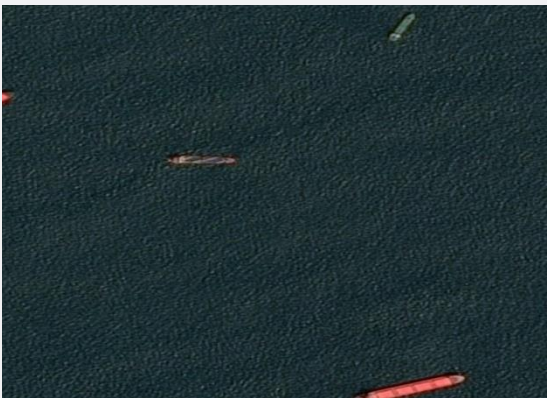
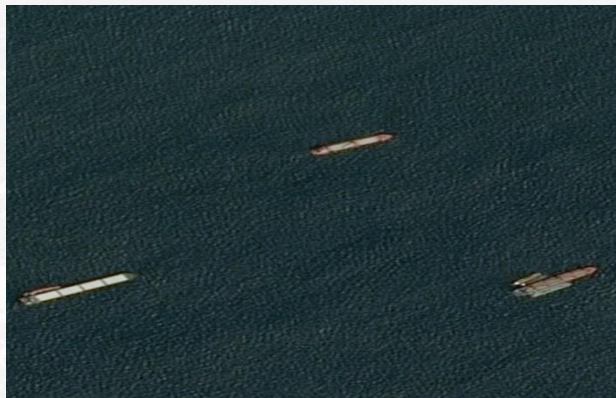
1. Deep learning algorithm based on Convolutional Neural Networks
2. Machine learning algorithm based on Support Vector Machines
3. Algorithm based on the contour code
4. Algorithm based on the contour code and thresholding

# SATELLITE IMAGERY DATASET 1

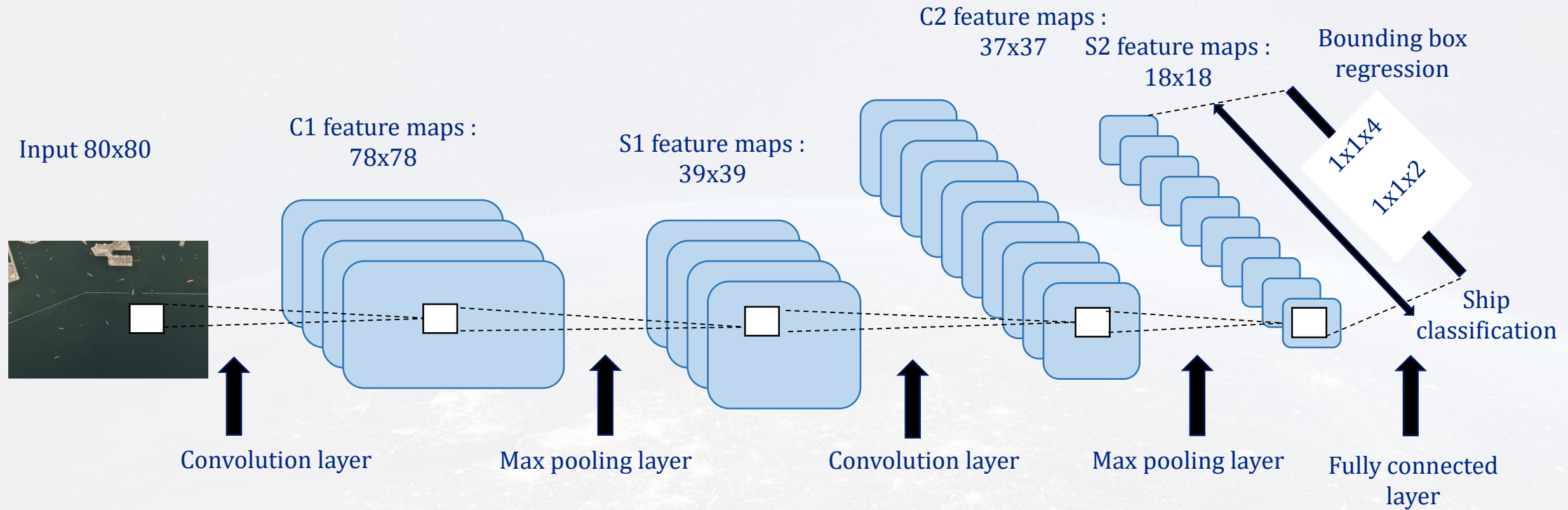
|                                                                                    |                                                                                     |                                                                                      |                                                                                      |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| ship_1.png                                                                         | Ship_2.png                                                                          | ship_3.png                                                                           | ship_4.png                                                                           |
|   |   |   |   |
| ship_5.png                                                                         | ship_6.png                                                                          | ship_7.png                                                                           | ship_8.png                                                                           |
|  |  |  |  |



# SATELLITE IMAGERY DATASET 2

| im01.jpg                                                                           | im02.jpg                                                                            | im03.jpg                                                                             | im04.jpg                                                                             |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|   |   |   |   |
| im05.jpg                                                                           | im06.jpg                                                                            | im07.jpg                                                                             | im08.jpg                                                                             |
|  |  |  |  |

# A DEEP LEARNING ALGORITHM BASED ON CNN



Programming language

Python 3

# A DEEP LEARNING ALGORITHM BASED ON CNN

Input Image



Deep-CNN / Conv 3x3



Deep-CNN / Conv 7x7



Deep-CNN / Conv 11x11





# CONFUSION MATRIX FOR DEEP-CNN ON THE WHOLE DATASET

## 3x3 window

|                    | Actual Positive | Actual Negative |
|--------------------|-----------------|-----------------|
| Predicted Positive | TP = 1672       | FP = 8          |
| Predicted Negative | FN = 9          | TN = 551        |

**Accuracy = 99.24%**

## 7x7 window

|                    | Actual Positive | Actual Negative |
|--------------------|-----------------|-----------------|
| Predicted Positive | TP = 1669       | FP = 11         |
| Predicted Negative | FN = 18         | TN = 542        |

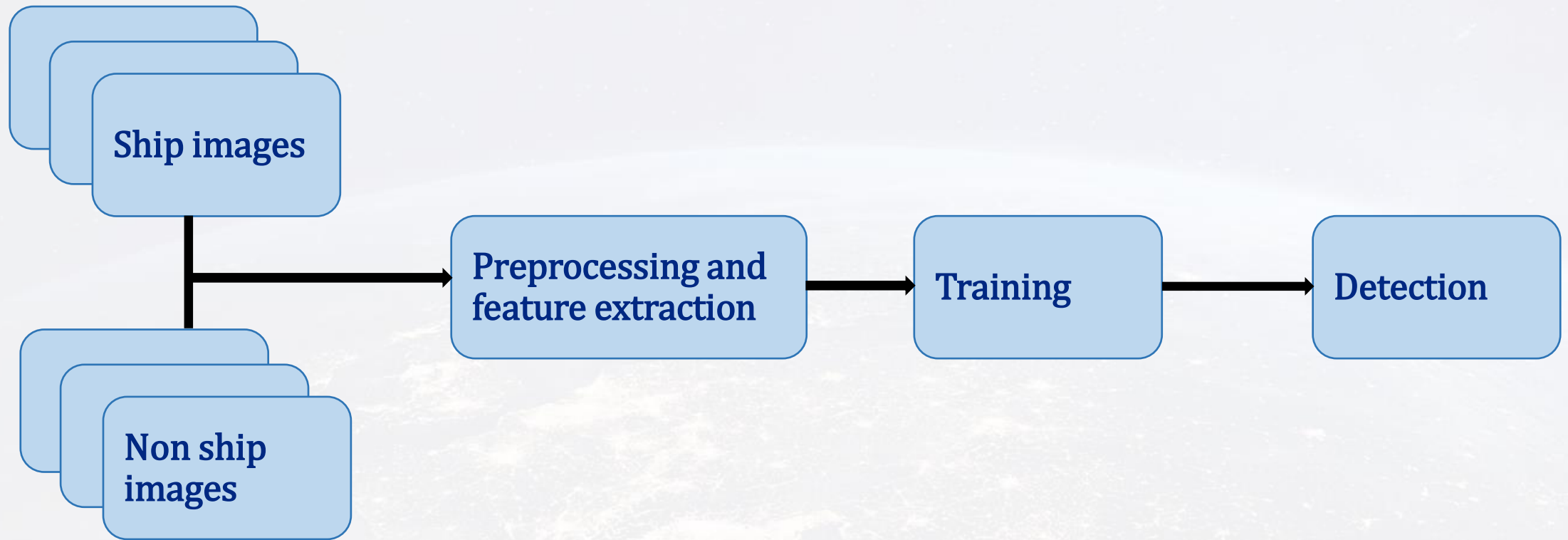
**Accuracy = 98.7%**

## 11x11 window

|                    | Actual Positive | Actual Negative |
|--------------------|-----------------|-----------------|
| Predicted Positive | TP = 1664       | FP = 16         |
| Predicted Negative | FN = 21         | TN = 539        |

**Accuracy = 98.34%**

# A MACHINE LEARNING ALGORITHM BASED ON SVM



**Programming language :** Matlab R2018a on Windows 64 Bytes processor x64

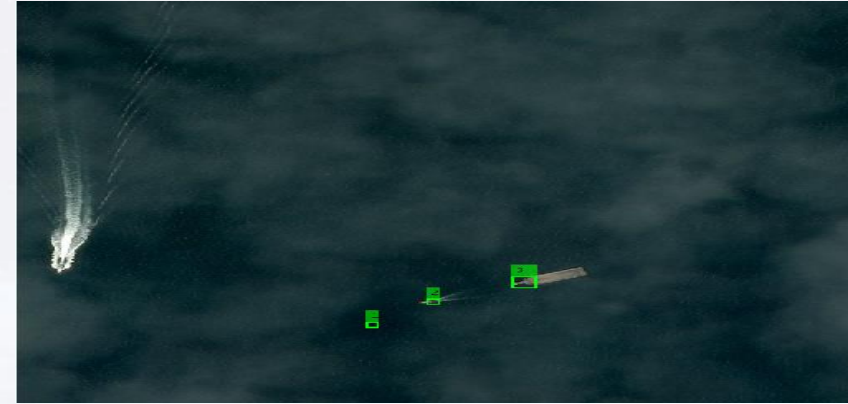


# A MACHINE LEARNING ALGORITHM BASED ON SVM

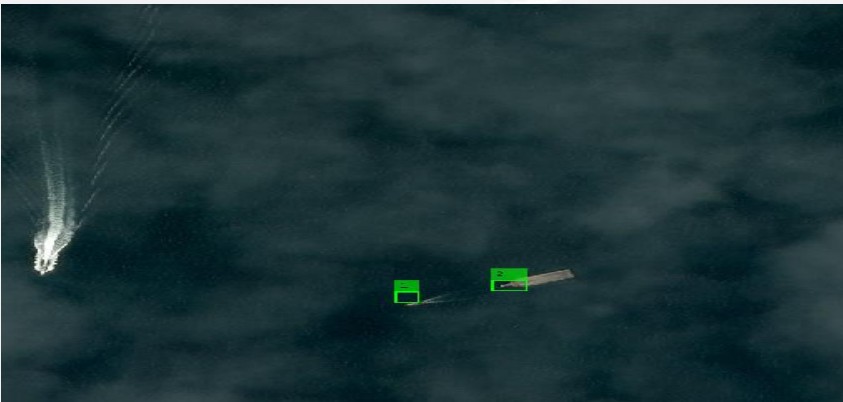
Input Image



SVM/window\_size: [10 10]



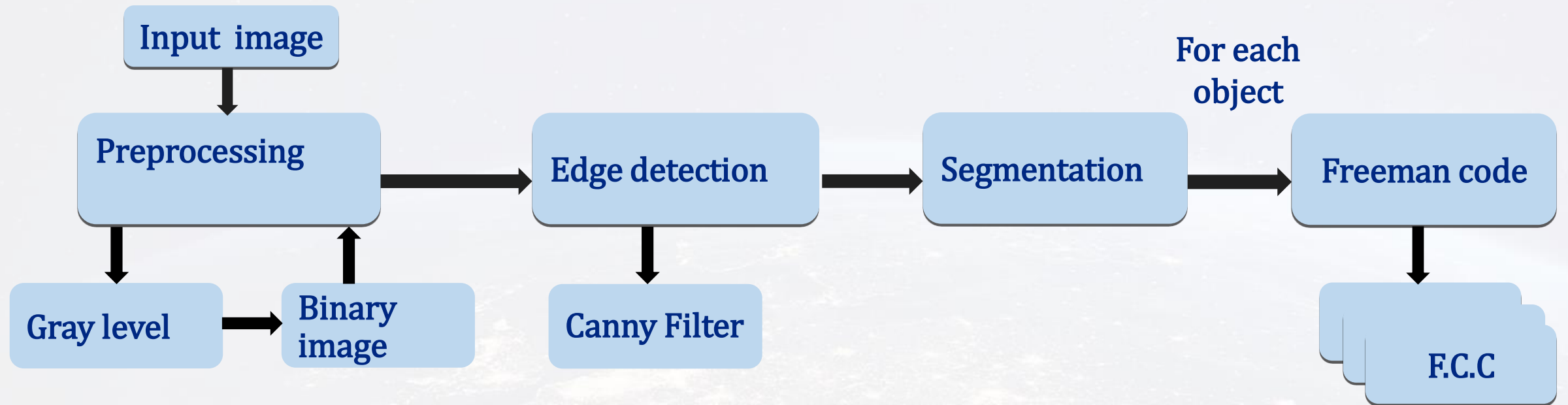
SVM/window\_size: [20 20]



SVM/window\_size: [30 30]



# AN ALGORITHM BASED ON THE CONTOUR CODE



**Programming language:** Matlab R2018a on Windows 64 Bytes processor x64

# AN ALGORITHM BASED ON THE CONTOUR CODE



|                     |        | True condition     |                    |
|---------------------|--------|--------------------|--------------------|
|                     |        | Condition positive | Condition negative |
| Predicted condition | Total  |                    |                    |
|                     | P.C.P  | TP : 10            | FP : 1             |
| P.C.                | P.C.N. | FN : 5             | TN : 7             |

**accuracy : 73,913%**



# AN ALGORITHM BASED ON THE CONTOUR CODE



|                     |        | True condition     |                    |
|---------------------|--------|--------------------|--------------------|
|                     |        | Condition positive | Condition negative |
| Predicted condition | Total  |                    |                    |
|                     | P.C.P  | TP : 26            | FP : 5             |
| P.C.                | P.C.N. | FN : 1             | TN : 7             |

**accuracy : 84,615%**

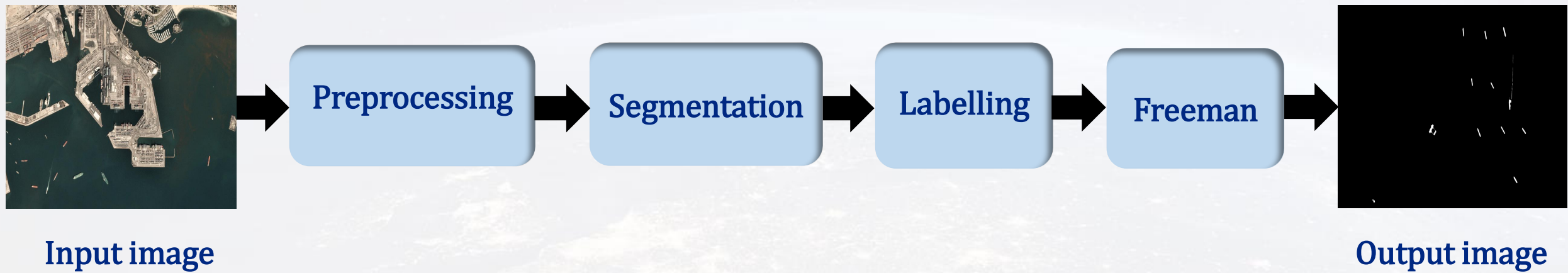
# AN ALGORITHM BASED ON THE CONTOUR CODE



|                     |        | True condition     |                    |
|---------------------|--------|--------------------|--------------------|
|                     |        | Condition positive | Condition negative |
| Predicted condition | Total  |                    |                    |
|                     | P.C.P  | TP : 17            | FP : 10            |
| P.C.                | P.C.N. | FN : 1             | TN : 8             |

accuracy : 69,444%

# AN ALGORITHM BASED ON THE CONTOUR CODE AND THRESHOLDING



# AN ALGORITHM BASED ON THE CONTOUR CODE AND THRESHOLDING



|                     |        | True condition     |                    |
|---------------------|--------|--------------------|--------------------|
|                     |        | Condition positive | Condition negative |
| Predicted condition | Total  |                    |                    |
|                     | P.C.P  | TP : 10            | FP : 1             |
| P.C.                | P.C.N. | FN : 6             | TN : 7             |

**accuracy : 70,833%**



# AN ALGORITHM BASED ON THE CONTOUR CODE AND THRESHOLDING



|                     |        | True condition     |                    |
|---------------------|--------|--------------------|--------------------|
|                     |        | Condition positive | Condition negative |
| Predicted condition | Total  |                    |                    |
|                     | P.C.P  | TP : 18            | FP : 10            |
| P.C.                | P.C.N. | FN : 1             | TN : 7             |

**accuracy : 69,444%**

# AN ALGORITHM BASED ON THE CONTOUR CODE AND THRESHOLDING



|                     |        | True condition     |                    |
|---------------------|--------|--------------------|--------------------|
|                     |        | Condition positive | Condition negative |
| Predicted condition | Total  |                    |                    |
|                     | P.C.P  | TP : 27            | FP : 3             |
| P.C.                | P.C.N. | FN : 1             | TN : 5             |

**accuracy : 88,888%**

# COMPUTATIONAL TIME FOR FIRST DATASET

## Contour code

| Image      | Size      | Date       | Preprocessing time | Segmentation time | Labelling time | Freeman time | Ships |
|------------|-----------|------------|--------------------|-------------------|----------------|--------------|-------|
| Ship_1.png | 1749x2001 | 04.03.2021 | 0.0088             | 0.7183            | 0.2671         | 0.3974       | 16    |
| Ship_2.png | 1828x2844 | 04.03.2021 | 0.0114             | 0.9847            | 0.2561         | 0.6783       | 27    |
| Ship_3.png | 1437x2393 | 04.03.2021 | 0.0080             | 0.6695            | 0.2567         | 0.2952       | 17    |
| Ship_4.png | 1477x2625 | 04.03.2021 | 0.0071             | 0.7567            | 0.3012         | 0.4096       | 14    |
| Ship_5.png | 1777x2825 | 04.03.2021 | 0.0089             | 0.9782            | 0.3992         | 0.2956       | 14    |
| Ship_6.png | 1597x3081 | 04.03.2021 | 0.0102             | 1.0072            | 0.4238         | 0.2804       | 13    |
| Ship_7.png | 1577x2709 | 04.03.2021 | 0.0085             | 0.8461            | 0.3093         | 0.2776       | 15    |
| Ship_8.png | 1007x2211 | 04.03.2021 | 0.0053             | 0.4429            | 0.1552         | 0.0436       | 10    |

## Contour code and thresholding

| Image      | Size      | Date       | Preprocessing time | Segmentation time | Labelling time | Freeman time | Ships |
|------------|-----------|------------|--------------------|-------------------|----------------|--------------|-------|
| Ship_1.png | 1749x2001 | 04.03.2021 | 0.0258             | 1.9454            | 0.2013         | 0.4625       | 13    |
| Ship_2.png | 1828x2844 | 04.03.2021 | 0.0058             | 0.1063            | 0.1234         | 0.9096       | 28    |
| Ship_3.png | 1437x2393 | 04.03.2021 | 0.0039             | 0.1247            | 0.1392         | 0.4459       | 19    |
| Ship_4.png | 1477x2625 | 04.03.2021 | 0.0044             | 0.1318            | 0.1370         | 0.3638       | 15    |
| Ship_5.png | 1777x2825 | 04.03.2021 | 0.0050             | 0.3703            | 0.2431         | 0.4143       | 13    |
| Ship_6.png | 1597x3081 | 04.03.2021 | 0.0055             | 0.1781            | 0.2564         | 0.4611       | 12    |
| Ship_7.png | 1577x2709 | 04.03.2021 | 0.0049             | 0.1954            | 0.1762         | 0.4343       | 15    |
| Ship_8.png | 1007x2211 | 04.03.2021 | 0.0029             | 0.1010            | 0.0964         | 0.1688       | 9     |

THANK YOU

ANY QUESTIONS?



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